STAFF REPORT ON WATER QUALITY RELATIVE TO PUBLIC HEALTH GOALS

2013-2015

City of Lodi
Public Works Department

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BACKGROUND

Provisions of the California Health and Safety Code Section 116470(b) require that larger (>10,000 service connections) water utilities prepare a special report every three years if their water quality measurements have exceeded any Public Health Goals (PHGs). PHGs are non-enforceable goals established by the California Environmental Protection Agency's (Cal-EPA) Office of Environmental Health Hazard Assessment (OEHHA). The law also requires that where OEHHA has not adopted a PHG for a constituent, the water suppliers are to use the Maximum Contaminant Level Goal (MCLG) adopted by United States Environmental Protection Agency (USEPA). Only constituents which have a California primary drinking water standard and for which either a PHG or MCLG has been set are to be addressed.

This report provides the following information as specified in the California Health and Safety Code Section 116470(b) for any contaminant detected in the City's water supply between 2013 and 2015 at a level exceeding a PHG or MCLG.

- Numerical public health risk associated with the Maximum Contaminant Level (MCL), and the PHG and MCLG;
- Category or type of risk to health that could be associated with each contaminant level;
- Best Available Treatment Technology (BAT) that could be used to reduce the contaminant level; and
- Estimate of the cost to install that treatment.

PUBLIC HEALTH GOALS

PHGs are set by the OEHHA, which is part of Cal-EPA, and are based solely on public health risk considerations. None of the practical risk-management factors that are considered by the USEPA or the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW), formally the California Department of Public Health (CDPH), in setting drinking water standards (MCLs) are considered in setting the PHGs. These factors include analytical detection capability, treatment technology available, benefits and costs. The PHGs are not enforceable and are not required to be met by any public water system. MCLGs are the federal equivalent to PHGs. Attachment 1 lists the regulated contaminates for which PHGs and MCLGs have been set.

CITY OF LODI WATER SOURCES

The majority of the City of Lodi's drinking water consists of groundwater sources (Twenty-eight wells). Approximately, 64 percent of the water supplied to our customers originates from wells owned by the City. The remaining 36 percent is treated surface water produced through the Surface Water Treatment Facility (SWTF). Water is diverted from the Mokelumne River (purchased from Woodbridge Irrigation District).

WATER QUALITY DATA CONSIDERED

All of the water quality data collected by our water system between 2013 and 2015 for purposes of determining compliance with drinking water standards was considered. This data was summarized in our 2013, 2014, and 2015 Annual Water Quality Reports which were mailed to all customers before July 1st each year.

GUIDELINES FOLLOWED

The Association of California Water Agencies (ACWA) formed a workgroup which prepared guidelines for water utilities to use in preparing these required reports. The ACWA guidelines were used in the preparation of our report.

BEST AVAILABLE TREATMENT TECHNOLOGY AND COST ESTIMATES

Treatment cost estimates for constituents listed are derived from the “Cost Estimates for Treatment Technologies” (included as Attachment 2) that were included as part of the ACWA guidance. Where provided, treatment costs are calculated using the information in Attachment 2 and each source’s production from 2015. Water production for each source can vary dramatically from year to year so the treatment cost associated with these estimates could also vary significantly. The estimates for specific treatment technologies do not include other factors such as permitting and waste disposal. Furthermore, before any treatment system is approved by DDW, the City is required to conduct a California Environmental Quality Act (also known as CEQA) review to assess potential environmental impacts that may be related to the project. The results of that assessment could add significant costs to mitigate potential concerns, or could preclude using a specific treatment technology altogether. Waste disposal costs associated with various treatment technologies vary widely. Some waste disposal costs are known and can be estimated as part of the routine operations and maintenance of the system. Others requiring direct discharge to the sanitary sewer or hauling of potentially hazardous waste would have to be determined on a case-by-case basis.

CONTAMINANTS DETECTED THAT EXCEED A PUBLIC HEALTH GOAL OR MAXIMUM CONTAMINANT LEVEL GOAL

The following is a discussion of constituents that were detected in one or more of our drinking water sources at levels above the PHG, or if no PHG, above the MCLG: Arsenic, Trichloroethylene (TCE), Dibromochloropropane (DBCP), Tetrachloroethylene (PCE), 1,2,3-Trichloropropane (1,2,3-TCP), Hexavalent Chromium, Uranium, Gross Alpha Particle Activity and Copper. This report only provides information on contaminants that were found in the City's drinking water system to have exceeded an established PHG or MCLG. The City of Lodi consistently delivers safe water at the lowest possible cost to our customers. The levels of these contaminants were below the MCLs, so they do not constitute a violation of drinking water regulations or indicate the water is unsafe to drink. These results could be considered typical for a Northern California water agency. The health risk information for regulated contaminants with PHGs is discussed in this report and also provided in Attachment 3.

Arsenic

Arsenic (As) is a naturally occurring element in the earth's crust and is very widely distributed in the environment. In general, humans are exposed to microgram (µg) quantities of As (inorganic and organic) largely from food (25 to 50 µg per day) and to a lesser degree from drinking water and air. Arsenic is used in industry as a component in wood preservatives, pesticides, paints, dyes, and semi-conductors. In most areas, erosion of rocks and minerals is considered to be the primary source of As in groundwater. Environmental contamination may result from anthropogenic sources such as: urban runoff, treated wood, pesticides, fly ash from power plants, smelting and mining wastes.

The MCL for As is 10 parts per billion (ppb) with a corresponding PHG of 0.004 ppb. OEHHA's April 2004, fact sheet: "Public Health Goal for Arsenic" summarizes the non-carcinogenic and carcinogenic health effects observed from studies involving drinking water with high levels of As. Studies cited have associated chronic intake of As in drinking water with the following non-carcinogenic health effects including: heart attack, stroke, diabetes mellitus, and hypertension. Other effects also include decreased production of erythrocytes and leukocytes, abnormal cardiac function, blood vessel damage, liver and/or kidney damage, and impaired nerve function in hands and feet (paresthesia). Characteristic skin abnormalities are also seen appearing as dark or light spots on the skin and small "corns" on the palms, soles, and trunk. Some of the corns may ultimately progress to skin cancer. Carcinogenic health effects involve an increased risk of cancer at internal sites, especially lung, urinary bladder, kidney, and liver. The health effects language in Appendix 64465-D of Title 22, California Code of Regulations states: "Some people who drink water containing arsenic in excess of the MCL over many years may experience skin damage or circulatory system problems, and may have an increased risk of getting cancer." The numerical health (cancer) risk for drinking water with As at the MCL is 2.5 in 1,000. The numerical health (cancer) risk for drinking water with As at the PHG is 1 in 1,000,000.

Arsenic levels in all City sources of supply are well below the regulatory standard.

Because the Detectable Level Required (DLR) for As is 2 ppb, the City is limited in its ability to report the presence of As only down to that level. As such, any As that may be present in sources at levels between the 0.004 ppb PHG and the 2 ppb DLR is unknown and not considered in this report. Water quality data for City sources from 2013-2015 show that As was detected in 26 City wells below the MCL (2.1 to 8.9 ppb). Two of the City wells are off-line and scheduled for rehabilitation; therefore, they are not included in the following treatment discussion. There has been no detection for As in the surface water supply.

The Best Available Technology (BAT) for arsenic removal is dependent on the water chemistry of the source to be treated. While research into new methods of removing arsenic continues, the current recommendations include:

- Activated Alumina
- Coagulation / Filtration
- Electrodialysis
- Ion Exchange
- Lime Softening
- Oxidation Filtration
- Reverse Osmosis

Since As levels in City's wells showing the presence of As are already below the MCL, reverse osmosis (RO) would likely be required to effectively decrease the amount of As present. The cost estimates for RO is $3.92 to $6.65 per 1,000 gallons of water treated. If RO treatment were considered for the 26 wells discussed above, the annualized capital and operation and maintenance (O&M) costs could range from approximately $8.9 million to $15.1 million per year. That would result in an assumed increased cost for each customer ranging from $337.81 to $573.07 per year.

Trichloroethylene (TCE)

Trichloroethylene (TCE) is a volatile organic compound that has been extensively used as a metal degreaser, a solvent in adhesives, textile manufacturing, paint stripping, and dry cleaning, etc. During industrial use, TCE's high vapor pressure allows a significant quantity of it to volatilize into the atmosphere. As a result of its widespread use and inadequate handling and disposal practices, TCE has become a common environmental contaminant. TCE has the most frequently exceeded drinking water MCL for a regulated organic compound in California.

The MCL for TCE is 5 ppb with a corresponding PHG of 1.7 ppb. In general, the following health effects discussion does not pertain to the low levels of TCE typically found in drinking water. OEHHA's July 2009 technical support report, "Public Health Goals for Chemicals in Drinking Water; Trichloroethylene" summarizes the health effects observed from studies involving human exposure to high levels of TCE. Because of TCE's widespread use and environmental contamination, the health effects on humans have been widely studied. Non-carcinogenic effects include: immediate symptomatic responses (headache, vomiting, loss of consciousness, etc.), cardiotoxicity, renal damage, hepatotoxicity, and many others. TCE is also associated with the following types of cancers: kidney, liver, cervix, lymphatic system. The health effects language in Appendix 64465-E of Title 22, California Code of Regulations states: “Some people who use water containing trichloroethylene in excess of the MCL over many years may experience liver problems and may have an increased risk of getting cancer.” The numerical health (cancer) risk for drinking water with TCE at the MCL is 3 in 1,000,000. The numerical health (cancer) risk for drinking water with TCE at the PHG is 1 in 1,000,000.

TCE levels in all City sources of supply are below the regulatory standard. Because the DLR for TCE is 0.5 ppb and the PHG is 1.7 ppb, the City is able to report concentrations of TCE below the PHG. Water quality data for City sources from 2013-2015 shows that TCE has been detected in two City wells. Levels of TCE in the three wells range from 0.5 to 2.0 ppb. There has been no detection for TCE in the surface water supply.

The approved BATs for treating TCE include the following treatment techniques:

1. Granular Activated Carbon (GAC)
2. Packed Tower Aeration

One of the three wells above the PHG for TCE is already equipped with GAC. To treat TCE below the PHG a more frequent GAC change-out would be required and the cost impact would be difficult to determine. If GAC were selected as the BAT to further reduce TCE in the additional two city wells (discussed above) to levels below the DLR, the cost would be estimated at $1.46 per 1,000 gallons of water treated. The annualized capital and O&M costs could range from approximately $178,000 per year. That would result in an assumed increased cost for each customer at $6.77 per year.

Dibromochloropropane (DBCP)

DBCP is a dense yellow organic liquid used as a nematocide (pesticide), but currently banned, that has remained in soils due to runoff or leaching from previous use on vegetables, soybeans, cotton, vineyards, and tree fruit.

The MCL or drinking water standard for DBCP is 200 parts per trillion (ppt). The PHG for DBCP is 1.7 ppt. The City detected DBCP at levels not exceeding the MCL in the discharges from 13 of Lodi’s 26 City wells used in 2013-2015. Levels of DBCP in the 13 wells range from 10 to 200 ppt. There has been no detection for DBCP in the surface water supply. The levels of DBCP were well below the MCLs, so they do not constitute a violation of drinking water regulations. In June 2014, City Well No. 6R was placed in service following the addition of Granulated Activated Carbon (GAC) vessels for treatment. This treatment was funded by Lodi’s settlement agreement with DBCP manufacturers. Currently seven City Wells are equipped with GAC to treat DBCP at levels above the MCL. Two of the City wells are off-line and scheduled for rehabilitation; therefore, they are not included in the following treatment discussion.

The BATs for DBCP to lower the level below the MCL is GAC. To attempt to maintain the DBCP levels to below the DLR (10 ppt), GAC Treatment Systems with longer empty bed contact times and more frequent carbon change-outs would likely be required. The health effects language in Appendix 64465-E of Title 22, California Code of Regulations states: “Some people who use water containing DBCP in excess of the MCL over many years may experience reproductive difficulties and may have an increased risk of getting cancer.” The numerical health (cancer) risk for drinking water with DBCP at the MCL is 1 in 10,000. The numerical health (cancer) risk for drinking water with DBCP at the PHG is 1 in 1,000,000.

The approved BATs for treating DBCP include the following treatment techniques:

1. Granular Activated Carbon (GAC)
2. Packed Tower Aeration

As mentioned above, seven of the thirteen wells above the PHG for DBCP are already equipped with GAC. To treat DBCP below the PHG a more frequent GAC change-out would be required and the cost impact would be difficult to determine. If GAC were selected as the BAT to further reduce DBCP in the additional six City wells (discussed above) to levels below the DLR of 10 ppt, the cost would be estimated at $ 0.48 per 1,000 gallons of water treated. The annualized capital and O&M costs would be approximately $180,000 per year. That would result in an assumed increased cost for each customer of $10.60 per year. (Note: this increase cost may not be reimbursable under the terms of Lodi's settlement agreement with DBCP manufacturers.)

Tetrachloroethylene

Tetrachloroethylene, also known as perchloroethylene (PCE), is primarily used as a chemical intermediate for the production of chlorofluorocarbons and as a solvent used in cleaning operations (metal cleaning, vapor degreasing, and dry cleaning). PCE has also been used in electric transformers as an insulating fluid and cooling gas. In addition, numerous household products contain some level of PCE. The high volatility of PCE results in a high potential for release into the environment during use. As a result of its widespread use and inadequate handling and disposal practices, PCE has become a common environmental contaminant.

The MCL for PCE is 5 ppb with a corresponding PHG of 0.06 ppb. OEHHA's August 2001, "Public Health Goal for Tetrachloroethylene in Drinking Water" summarizes the health effects observed from studies involving human exposure to high levels of PCE. Non-carcinogenic health effects include: kidney disease, developmental and reproductive toxicity, neurotoxicity and genetic mutations. Also, the same immediate symptomatic responses associated with exposure to high levels of PCE may occur. Carcinogenic health effects include: kidney, liver, cervix, and lymphatic system cancers. Due to the low levels typically involved, exposures to PCE in drinking water are not expected to result in any acute health effects. Exposure from drinking water can be in the form of household airborne exposures from showering, flushing of toilets, and other contact with water. PCE is readily absorbed through the lungs and gastrointestinal tract, and to a lesser extent it can be absorbed through the skin. The health effects language in Appendix 64465-E of Title 22, California Code of Regulations states: "Some people who use water containing tetrachloroethylene in excess of the MCL over many years may experience liver problems, and may have an increased risk of getting cancer." The numerical health (cancer) risk for drinking water with PCE at the MCL is 8 in 100,000. The numerical health (cancer) risk for drinking water with PCE at the PHG is 1 in 1,000,000.

PCE levels in all City sources of supply are well below the regulatory standard. Because the DLR for PCE is 0.5 ppb, the City is limited in its ability to report the presence of PCE only down to that level. As such, any PCE that may be present in sources at levels between the 0.06 ppb PHG and the 0.5 ppb DLR is unknown and not considered in this report. Water quality data for City sources from 2013-2015 shows that PCE has been detected in three City wells over the PHG. Levels of PCE in the City wells range from 0.5 to 2.1 ppb. There has been no detection for PCE in the surface water supply.

The approved BATs for treating PCE include the following treatment techniques:

1. Granular Activated Carbon (GAC)
2. Packed Tower Aeration

One of the three wells above the PHG for PCE is already equipped with GAC. To treat PCE below the PHG a more frequent GAC change-out would be required and the cost impact would be difficult to determine. If GAC were selected as the BAT to further reduce PCE in the additional two city wells (discussed above) to levels below the DLR, the cost could range from $ 0.26 to $1.46 per 1,000 gallons of water treated. The annualized capital and O&M costs could range from approximately $21,000 to $119,000 per year. That would result in an assumed increased cost for each customer ranging from $0.80 to $4.50 per year.

1,2,3-Trichloropropane

1,2,3-Trichloropropane (1,2,3-TCP) is a manmade chlorinated hydrocarbon that is typically found at industrial or hazardous waste sites and has been used as a cleaning and degreasing solvent. 1,2,3-TCP is also associated with pesticide products formulated with dichloropropanes in the manufacturing of soil fumigants (nematicide) D-D, (no longer available in the United States) which does not attach to soil particles and may move into groundwater aquifers.

The PHG for 1,2,3-TCP is 0.0007 micrograms per liter (ppb or parts per billion). 1,2,3-TCP is an unregulated chemical currently without a California or Federal Maximum Contaminant Level (MCL) for 1,2,3-TCP. The California Notification Level for 1,2,3-TCP is set at 0.005 ppb, the detection limit for the purposes of reporting Detectable Level Required (DLR).

Notification levels are health-based advisory levels established by OEHHA for chemicals in drinking water that lack MCLs. OEHHA advises "If a chemical concentration is greater than its notification level in drinking water that is provided to consumers, OEHHA recommends that the utility inform its customers and consumers about the presence of the chemical, and about health concerns associated with exposure to it”. 1,2,3-TCP was sampled in 2013 as part of the Unregulated Containments Monitoring Rule 3 (UCMR3). UCMR3 is a monitoring program administered by the USEPA. This monitoring provides a basis for future regulatory actions to protect public health. The City detected 1,2,3-TCP at levels exceeding the PHG in the source water from eight City wells. Of these eight wells, only six wells were detected above the DLR of 0.005 ppb.

Currently, there is no MCL for 1,2,3-TCP. The category for health risk associated with 1,2,3-TCP, and the reason that a drinking water standard (PHG) was adopted for it, is the people who drink water containing 1,2,3-TCP throughout their lifetime could theoretically experience an increased risk of getting cancer. The numerical health (cancer) risk for drinking water with 1,2,3-TCP at the MCL is not available since no MCL has been established. The numerical health (cancer) risk for drinking water with 1,2,3-TCP at the PHG is 1 in 1,000,000.

Because the DLR for 1,2,3-TCP is 0.005 ppb, the City is limited in its ability to report the presence of 1,2,3-TCP only down to that level. As such, any 1,2,3-TCP that may be present in sources at levels between the 0.0007 ppb PHG and the 0.005 ppb DLR is unknown and not considered in this report. Water quality data for City sources from 2013-2015 shows that 1,2,3-TCP has been detected in six City wells over the PHG and above the DLR. Of these six wells, four are equipped with GAC for removal of DBCP. Levels of 1,2,3-TCE detected in the City wells range from 0.005 to 0.030 ppb. There has been no detection for 1,2,3-TCE in the surface water supply.

The approved BATs for treating 1,2,3-TCP include the following treatment techniques:

1. Granular Activated Carbon (GAC)
2. Packed Tower Aeration

As mentioned above, four of the six wells above the PHG for 1,2,3-TCP are already equipped with GAC. To treat 1,2,3-TCP below the PHG a more frequent GAC change-out would be required and the cost impact would be difficult to determine. If GAC were selected as the BAT to further reduce 1,2,3-TCP in the additional two city wells (discussed above) to levels below the DLR, the cost could range from $ 0.26 to $1.46 per 1,000 gallons of water treated. The annualized capital and O&M costs could range from approximately $26,000 to $148,000 per year. That would result in an assumed increased cost for each customer ranging from $1.10 to $5.62 per year. Cost may need to be reassessed following adoption of California MCL.

Hexavalent Chromium

Chromium (Cr) is a naturally-occurring element that is found in rocks, soils, plants and animals. Cr has a variety of industrial uses that include: steel making, metal plating, corrosion inhibitors, paints and wood preservatives. The most common forms of Cr in the environment are trivalent (Cr+3) and hexavalent (Cr+6). Cr+3 is an essential nutrient for humans and is the more common form found in surface waters. In areas where igneous rocks are present, the major source of Cr+6 in groundwater is from the oxidation of naturally-occurring Cr. Cr+6 can also result in groundwater from the oxidation of Cr+3 during the disinfection process. Anthropogenic sources of Cr+6 in groundwater typically result from leakage, poor storage and improper disposal practices.

The MCL for Cr+6 is 10 ppb with a corresponding PHG of 0.02 ppb. OEHHA’s July 2011, Fact Sheet: “Final Public Health Goal for Hexavalent Chromium” summarizes the health effects observed from studies involving drinking water with high levels of Cr+6. They include significant numbers of gastrointestinal tumors in rats and mice as well as increased rates of stomach cancer in humans. There is also evidence that Cr+6 can damage DNA. Exposure to airborne Cr+6 is 1,000 times more potent than exposure from drinking water. The health effects language in Appendix 64465-D of Title 22, California Code of Regulations states: “Some people who drink water containing Cr+6 in excess of the MCL over many years may have an increased risk of getting cancer.” The numerical health (cancer) risk for drinking water with Cr+6 at the MCL is 5 in 10,000. The numerical health (cancer) risk for drinking water with Cr+6 at the PHG is 1 in 1,000,000.

Cr+6 levels in all City sources of supply are below the regulatory standard of 10 ppb. Because the DLR for Cr+6 is 1 ppb, the City is limited to reporting the presence of Cr+6 only down to that level. As such, any Cr+6 that may be present in sources at levels between the 0.02 ppb PHG and the 1 ppb DLR is unknown and not considered in this report. Water quality data for City sources from 2013-2015 shows that Cr+6 has been detected in 25 City wells above the PHG. Levels of Cr+6 in wells range from 1.0 to 8.3 ppb. Two wells are off-line and scheduled for rehabilitation; therefore, they are not included in the following treatment discussion. There has been no detection for Cr+6 in the surface water supply.

The approved BAT for treating Cr+6 includes the following treatment techniques:

1. Coagulation/Filtration
2. Ion Exchange
3. Reverse Osmosis

Ion Exchange (IX), specifically, Weak Base Anion Exchange Resin could be used to further reduce Cr+6 in City wells to levels below the DLR and closer to the PHG. Cost estimates for IX range from $1.62 to $6.78 per 1,000 gallons of water treated. If IX treatment were considered for the 25 wells discussed above, the annualized capital and O&M costs could range from approximately $3.6 million to $15.2 million per year. That would result in an assumed increased cost for each customer ranging from $138.12 to $578.05 per year.

Uranium

Uranium (U) is one of several naturally-occurring radioactive metals that emit alpha (and beta) radiation. U has three primary naturally-occurring isotopes (U234, U235 and U238). All three isotopes of U are radioactive with U238 (approximately 99%) being the most common. Radioactive decay of U produces Radium (Ra), which in turn decays to radon gas. U occurs at trace levels in most rocks, soil, water, plants and animals. U is weakly radioactive and therefore, contributes to low levels of radioactivity in the environment. Elevated levels of U found in the environment are typically associated with U mining and the techniques used to remove it. Concentrations of U may also occur in the environment as a result of improper handling or disposal practices. U is enriched before it is used for power generation in nuclear reactors or for use in weapons. Before the radioactive properties of U were known, it was used as a yellow coloring for pottery and glassware.

The MCL for U is 20 picoCuries per liter (pCi/L) with a corresponding PHG of 0.43 pCi/L. Unlike Ra, the individual isotopes of U do not have their own specific PHG. OEHHA's August 2001 technical support report, "Public Health Goals for Chemicals in Drinking Water; Uranium" summarizes the health effects observed from studies involving human exposure to high levels of U. Non-carcinogenic effects include kidney and liver disease. Lung cancer is the main type of cancer associated with exposure to high levels of U. USEPA has classified U as a "Class A" carcinogen, even though there is no direct evidence that it is carcinogenic in humans. The health effects discussed above appear to be associated with the emission of ionizing radiation from radioactive daughter products. The health effects language in Appendix 64465-C of Title 22, California Code of Regulations states: "Some people who drink water containing uranium in excess of the MCL over many years may have kidney problems or an increased risk of getting cancer." The numerical health (cancer) risk for drinking water with U at the MCL is 5 in 100,000. The numerical health (cancer) risk for drinking water with U at the PHG is 1 in 1,000,000.

The levels of U in City sources of supply are below the regulatory standard. Because the DLR for U is 1 pCi/L, the City is limited in its ability to report the presence of U only down to that level. As such, any U that may be present in sources at levels between the 0.43 pCi/L PHG and the 1 pCi/L DLR is unknown and not considered in this report. Water quality data for City sources from 2013-2015 shows that U has been detected in 18 City wells. Levels of U reported for the City wells range from 1.0 to 10.2 pCi/L. There has been no detection for U in the surface water supply.

The approved BATs for treating U include the following treatment techniques:

1. Ion Exchange
2. Reverse Osmosis
3. Lime Softening
4. Coagulation/Filtration

The most effective method to reduce U and the other radionuclides discussed previously is to install RO treatment at select groundwater wells where results exceed the PHG and are detectable at levels above the DLR. Cost estimates for RO range from $3.92 to $6.65 per 1,000 gallons of water treated. If RO treatment were considered for the 18 wells discussed above, the annualized capital and O&M costs could range from approximately $5.3 million to $9.0 million per year. That would result in an assumed increased cost for each customer ranging from $201.26 to $341.42 per year.

Gross Alpha Particle Activity

Certain minerals are radioactive and may emit a form of radiation known as alpha radiation. Gross alpha particle activity (GA) is a measurement of the overall alpha radiation emitted when certain elements such as uranium and radium undergo radioactive decay. Alpha radiation exists in the air, soil and water. Naturally-occurring alpha radiation in groundwater results mainly from the dissolution of minerals as the water seeps into the ground, and as water moves through aquifers. Detectable levels of GA above the DLR are used to determine when additional radionuclide speciation (monitoring) is required.

The MCL for GA is 15 pCi/L. Because GA is associated with a group of radioactive elements rather than an individual contaminant, OEHHA determined it is not practical to establish a PHG for it. GA is known to cause cancer; therefore, USEPA established the MCLG at zero pCi/L. The actual cancer risk from radionuclides emitting alpha radiation in drinking water depends on the particular radionuclide present and the average consumption over a lifetime. Alpha radiation loses energy rapidly and doesn’t pass through the skin; therefore, it is not a health hazard outside of the body. Typical exposure routes for alpha radiation include: eating, drinking, and inhaling alpha-emitting particles. General, non-carcinogenic health effects associated with ingesting elevated levels of alpha radiation include kidney damage, damage to cells and DNA and damage to other vital organs. Specific cancers that may result from exposure to elevated levels of alpha radiation include: bone cancer and cancer of particular organs, each of which are associated with specific alpha-radiation emitters. The health effects language in Appendix 64465-C of Title 22, California Code of Regulations states: “Certain minerals are radioactive and may emit a form of radiation known as alpha radiation. Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.” The numerical health (cancer) risk for drinking water with the most radiotoxic alpha particle emitter at the MCL is: 1 in 1,000. The numerical health (cancer) risk for drinking water with GA at the MCLG is zero.

GA levels in City sources of supply are below the regulatory standard. Because the DLR for GA is 3 pCi/L; the City is limited to reporting the presence of GA only down to that level. As such, any GA that may be present in sources at levels between the zero pCi/L MCLG and the 3 pCi/L DLR is unknown and not considered in this report. Water quality data for City sources from 2013-2015 shows that GA has been detected eight City wells above the DLR. Levels of GA in the City wells range from 3.68 to 11.80 pCi/L. There has been no detection for GA in the surface water supply.

The BAT identified to treat GA is RO. The most effective method to reduce GA is to install RO treatment at select groundwater wells where results exceed the MCLG, and are detectable at levels above the DLR. Cost estimates for RO range from $3.92 to $6.65 per 1,000 gallons of water treated. If RO treatment were considered for the eight wells discussed above, the annualized capital and O&M costs could range from approximately $2.5 million to $4.3 million per year. That would result in an assumed increased cost for each customer ranging from $96.27 to $163.32 per year.

Copper

Copper is an essential nutrient, but it is toxic if ingested at high levels. Children under 10 years of age appear to be particularly susceptible to copper toxicity. Copper may enter the water from natural sources or may enter tap water in the distribution system of the individual households.

Instead of adopting an MCL for Cu, USEPA and DDW have adopted an Action Level (AL) set at the 90th percentile value of all samples from household taps in the distribution system. That level is set at 1300 ppb for Cu. The corresponding PHG is 300 ppb. OEHHA's August 2008 technical support report, "Public Health Goals for Chemicals in Drinking Water; Copper" summarizes the health effects observed from studies involving human exposure to elevated levels of copper. Non-carcinogenic health effects include: gastrointestinal distress (GI), GI bleeding and liver and kidney failure. Cu is not considered a carcinogen. The health effects language for Cu in Appendix 64465-D of Title 22, California Code of Regulations states: "Copper is an essential nutrient, but some people who drink water containing copper in excess of the action level over a relatively short period of time may experience gastrointestinal distress. Some people who drink water containing copper in excess of the action level over many years may suffer liver or kidney damage. People with Wilson's Disease should consult their personal doctor." As noted above, the numerical (non-cancer) health risks for drinking water with Cu at the AL and PHG have not yet been provided by OEHHA.

In 2013, 2014, and 2015, the City conducted Cu sampling as part of the triennial lead and copper monitoring. The results showed that in the system overall, the 90th percentile result was 400 ppb for Cu. This was well below the AL; however, the level for Cu exceeds the 300 ppb PHG.

The City's water system is in full compliance with both the Federal and State Lead and Copper Rules. Based on sampling in between 2013-2015, it was determined, according to

USEPA and state regulatory requirements, that the City meets the AL for Cu. Therefore, the City is deemed by DDW to have optimized corrosion control for its system.

In general, optimizing corrosion control is considered to be the BAT to deal with corrosion issues that may be present in a water system.

Since the City is meeting the “optimized corrosion control” requirements, it may not be prudent to initiate additional corrosion control treatment as it involves the addition of other chemicals, which could likely cause other water quality issues. Therefore, no estimate of cost has been included.

Total Coliform (Informational Purposes Only)

Total coliform bacteria are tested at sampling sites throughout the City’s water distribution system to comply with the Total Coliform Rule (TCR). In 2013-15, the City collected between 80 and 100 samples per month from our distribution system for coliform analysis. Of these samples, zero were positive for coliform bacteria and the City has achieved our MCLG.

For large systems the MCL for coliform under the TCR is 5% positive samples of all samples per month and the MCLG is zero. The reason for the coliform drinking water standard is to minimize the possibility of the water containing pathogens which are organisms that cause waterborne disease. Because coliform is only an indicator of the potential presence of pathogens, it is not possible to state a specific numerical health risk. While U.S. EPA normally sets MCLGs “at a level where no known or anticipated adverse effects on persons would occur” they indicate that they cannot do so with coliforms.

Coliform bacteria are organisms that are found just about everywhere in nature and are not generally considered harmful. They are used as an indicator because of the ease in monitoring and analysis. If a positive sample is found, it indicates a potential problem that needs to be investigated and follow up sampling done. It is not at all unusual for a system to have an occasional positive sample. It is difficult, if not impossible; to assure that a system will never get a positive sample. A further test that is performed on all positive total coliform results is for Fecal Coliform or Escherichia coli (*E. Coli)*. There were no positive Fecal Coliform or *E. Coli* results in 2013-15.

The City adds chlorine to all our sources to assure that the water served is microbiologically safe. The chlorine residual levels are carefully controlled to provide the best health protection without causing the water to have undesirable taste and odor or increasing the disinfection byproduct level. This careful balance of treatment processes is essential to continue supplying our customers with safe drinking water.

Other equally important measures that the City has implemented include:

- An effective water quality monitoring program;
- A flushing program in which water pipelines known to have little use are flushed to remove water age and bring in fresh water with an adequate chlorine residual;
- An effective cross-connection control program that prevents the accidental entry of potentially contaminated water into the drinking water system; and

- Maintaining positive pressure in the distribution system.

Since the City has reached the PHG of zero positive total coliform samples, no cost estimate has been included for this constituent.

RECOMMENDATIONS FOR FURTHER ACTION

The drinking water quality of the City of Lodi Public Water System meets all State of California, Department of Health Services and USEPA drinking water standards set to protect public health. To further reduce the levels of the constituent's identified in this report that are already below the Maximum Contaminant Levels established by the State and Federal government, additional costly treatment processes would be required.

The effectiveness of the treatment processes to provide any significant reductions in constituent levels at these already low values is uncertain. The theoretical health protection benefits of these further hypothetical reductions are not at all clear and may not be quantifiable. Therefore, staff is not recommending further action at this time. However, the point of this process is to provide you with information on water quality in Lodi and cost estimates to make certain improvements.

More Information

This report was completed by City of Lodi Public Works Department staff. Any questions relating to this report should be directed to:

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Appendix A

List of Abbreviations

1,2,3-TCP	1,2,3-Trichloropane
ACWA	Association of California Water Agencies
AL	Action Level
As	Arsenic
BAT	Best Available Technology
Cal-EPA	California Environmental Protection Agency
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
Cr	Chromium
DBCP	Dibromochloropropane
DDW	State Water Resources Control Board, Division of Drinking Water (formerly known as the California Department of Public Health, Drinking Water Program)
DLR	Detection Limit for the Purposes of Reporting
E. Coli	Escherichia coli
GAC	Granular Activated Charcoal
GA	Gross Alpha particle activity
GI	Gastrointestinal
IX	Ion Exchange
µg	Microgram
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
OEHHA	Office of Environmental Health Hazard Assessment
ppb	parts per billion, or equivalent to micrograms per liter
PCE	Tetrachloroethylene, also known as perchloroethylene
pCi/L	picoCuries per liter
PHG	Public Health Goal
Ra	Radium
RO	Reverse Osmosis
SWRCB	State Water Resources Control Board
SWTF	Surface Water Treatment Facility
TCE	Trichloroethylene
U	Uranium
UCMR3	Unregulated Containments Monitoring Rule 3
USEPA	United States Environmental Protection Agency

Attachment 1

MCLs, DLRs, and PHGs for Regulated Drinking Water Contaminants (Units are in milligrams per liter (mg/L), unless otherwise noted.) Last Update: July 22, 2016				
This table includes: California's maximum contaminant levels (MCLs) Detection limits for purposes of reporting (DLRs) Public health goals (PHGs) from the Office of Environmental Health Hazard Assessment (OEHHA) Also, PHGs for NDMA and 1,2,3-Trichloropropane (which are not yet regulated) are included at the bottom of this table.				
	MCL	**DLR**	**PHG**	**Date of PHG**
Chemicals with MCLs in 22 CCR §64431—Inorganic Chemicals				
Aluminum	1	0.05	0.6	2001
Antimony	0.006	0.006	0.02	1997
Antimony	--	--	0.0007	2009 draft
Arsenic	0.010	0.002	0.000004	2004
Asbestos (MFL = million fibers per liter; for fibers >10 microns long)	7 MFL	0.2 MFL	7 MFL	2003
Barium	1	0.1	2	2003
Beryllium	0.004	0.001	0.001	2003
Cadmium	0.005	0.001	0.00004	2006
Chromium, Total - OEHHA withdrew the 0.0025-mg/L PHG	0.05	0.01	withdrawn Nov. 2001	1999
Chromium, Hexavalent	0.010	0.001	0.00002	2011
Cyanide	0.15	0.1	0.15	1997
Fluoride	2	0.1	1	1997
Mercury (inorganic)	0.002	0.001	0.0012	1999 (rev2005)*
Nickel	0.1	0.01	0.012	2001
Nitrate (as NO3)	45	2	45	1997
Nitrite (as N)	1 as N	0.4	1 as N	1997
Nitrate + Nitrite	10 as N	--	10 as N	1997
Perchlorate	0.006	0.004	0.006	2004
Perchlorate	--	--	0.001	2012 draft
Selenium	0.05	0.005	0.03	2010
Thallium	0.002	0.001	0.0001	1999 (rev2004)
Copper and Lead, 22 CCR §64672.3				
Values referred to as MCLs for lead and copper are not actually MCLs; instead, they are called "Action Levels" under the lead and copper rule				
Copper	1.3	0.05	0.3	2008
Lead	0.015	0.005	0.0002	2009

Radionuclides with MCLs in 22 CCR §64441 and §64443—Radioactivity				
[units are picocuries per liter (pCi/L), unless otherwise stated; n/a = not applicable]				
Gross alpha particle activity - OEHHA concluded in 2003 that a PHG was not practical	15	3	none	n/a
Gross beta particle activity - OEHHA concluded in 2003 that a PHG was not practical	4 mrem/yr	4	none	n/a
Radium-226	--	1	0.05	2006
Radium-228	--	1	0.019	2006
Radium-226 + Radium-228	5	--	--	--
Strontium-90	8	2	0.35	2006
Tritium	20,000	1,000	400	2006
Uranium	20	1	0.43	2001
Chemicals with MCLs in 22 CCR §64444—Organic Chemicals				
(a) Volatile Organic Chemicals (VOCs)				
Benzene	0.001	0.0005	0.00015	2001
Carbon tetrachloride	0.0005	0.0005	0.0001	2000
1,2-Dichlorobenzene	0.6	0.0005	0.6	1997 (rev2009)
1,4-Dichlorobenzene (p-DCB)	0.005	0.0005	0.006	1997
1,1-Dichloroethane (1,1-DCA)	0.005	0.0005	0.003	2003
1,2-Dichloroethane (1,2-DCA)	0.0005	0.0005	0.0004	1999 (rev2005)
1,1-Dichloroethylene (1,1-DCE)	0.006	0.0005	0.01	1999
cis-1,2-Dichloroethylene	0.006	0.0005	0.1	2006
trans-1,2-Dichloroethylene	0.01	0.0005	0.06	2006
Dichloromethane (Methylene chloride)	0.005	0.0005	0.004	2000
1,2-Dichloropropane	0.005	0.0005	0.0005	1999
1,3-Dichloropropene	0.0005	0.0005	0.0002	1999 (rev2006)
Ethylbenzene	0.3	0.0005	0.3	1997
Methyl tertiary butyl ether (MTBE)	0.013	0.003	0.013	1999
Monochlorobenzene	0.07	0.0005	0.07	2014
Styrene	0.1	0.0005	0.0005	2010
1,1,2,2-Tetrachloroethane	0.001	0.0005	0.0001	2003
Tetrachloroethylene (PCE)	0.005	0.0005	0.00006	2001
Toluene	0.15	0.0005	0.15	1999
1,2,4-Trichlorobenzene	0.005	0.0005	0.005	1999
1,1,1-Trichloroethane (1,1,1-TCA)	0.2	0.0005	1	2006
1,1,2-Trichloroethane (1,1,2-TCA)	0.005	0.0005	0.0003	2006
Trichloroethylene (TCE)	0.005	0.0005	0.0017	2009
Trichlorofluoromethane (Freon 11)	0.15	0.005	1.3	2014
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	1.2	0.01	4	1997 (rev2011)
Vinyl chloride	0.0005	0.0005	0.00005	2000
Xylenes	1.75	0.0005	1.8	1997

(b) Non-Volatile Synthetic Organic Chemicals (SOCs)				
Alachlor	0.002	0.001	0.004	1997
Atrazine	0.001	0.0005	0.00015	1999
Bentazon	0.018	0.002	0.2	1999 (rev2009)
Benzo(a)pyrene	0.0002	0.0001	0.000007	2010
Carbofuran	0.018	0.005	0.0017	2000
Chlordane	0.0001	0.0001	0.00003	1997 (rev2006)
Dalapon	0.2	0.01	0.79	1997 (rev2009)
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	0.00001	0.0000017	1999
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.07	0.01	0.02	2009
Di(2-ethylhexyl)adipate	0.4	0.005	0.2	2003
Di(2-ethylhexyl)phthalate (DEHP)	0.004	0.003	0.012	1997
Dinoseb	0.007	0.002	0.014	1997 (rev2010)
Diquat	0.02	0.004	0.015	2000
Endrin	0.002	0.0001	0.0018	1999 (rev2008)
Endothal	0.1	0.045	0.094	2014
Ethylene dibromide (EDB)	0.00005	0.00002	0.00001	2003
Glyphosate	0.7	0.025	0.9	2007
Heptachlor	0.00001	0.00001	0.000008	1999
Heptachlor epoxide	0.00001	0.00001	0.000006	1999
Hexachlorobenzene	0.001	0.0005	0.00003	2003
Hexachlorocyclopentadiene	0.05	0.001	0.002	2014
Lindane	0.0002	0.0002	0.000032	1999 (rev2005)
Methoxychlor	0.03	0.01	0.00009	2010
Molinate	0.02	0.002	0.001	2008
Oxamyl	0.05	0.02	0.026	2009
Pentachlorophenol	0.001	0.0002	0.0003	2009
Picloram	0.5	0.001	0.5	1997
Polychlorinated biphenyls (PCBs)	0.0005	0.0005	0.00009	2007
Simazine	0.004	0.001	0.004	2001
2,4,5-TP (Silvex)	0.05	0.001	0.003	2014
2,3,7,8-TCDD (dioxin)	$3x10^{-8}$	$5x10^{-9}$	$5x10^{-11}$	2010
Thiobencarb	0.07	0.001	0.07	2000
Toxaphene	0.003	0.001	0.00003	2003

Chemicals with MCLs in 22 CCR §64533 —Disinfection Byproducts				
Total Trihalomethanes	0.080	--	0.0008	2010 draft
Bromodichloromethane	--	0.0010	--	--
Bromoform	--	0.0010	--	--
Chloroform	--	0.0010	--	--
Dibromochloromethane	--	0.0010	--	--
Haloacetic Acids (five) (HAA5)	0.060	--	--	--
Monochloroacetic Acid	--	0.0020	--	--
Dichloroacetic Adic	--	0.0010	--	--
Trichloroacetic Acid	--	0.0010	--	--
Monobromoacetic Acid	--	0.0010	--	--
Dibromoacetic Acid	--	0.0010	--	--
Bromate	0.010	0.0050**	0.0001	2009
Chlorite	1.0	0.020	0.05	2009
Chemicals with PHGs established in response to CDPH requests. These are not currently regulated drinking water contaminants.				
N-Nitrosodimethylamine (NDMA)	--	--	0.000003	2006
1,2,3-Trichloropropane	--	--	0.0000007	2009
*OEHHA's review of this chemical during the year indicated (rev20XX) resulted in no change in the PHG.				
**The DLR for Bromate is 0.0010 mg/L for analysis performed using EPA Method 317.0 Revision 2.0, 321.8, or 326.0.				

Attachment 2
Table 1
Reference: 2012 ACWA PHG Survey

COST ESTIMATES FOR TREATMENT TECHNOLOGIES
(INCLUDES ANNUALIZED CAPITAL AND O&M COSTS)

No.	Treatment Technology	Source of Information	Estimated Unit Cost 2012 ACWA Survey Indexed to 2015* ($/1,000 gallons treated)
1	Ion Exchange	Coachella Valley WD, for GW, to reduce Arsenic concentrations. 2011 costs.	1.99
2	Ion Exchange	City of Riverside Public Utilities, for GW, for Perchlorate treatment.	0.96
3	Ion Exchange	Carollo Engineers, anonymous utility, 2012 costs for treating GW source for Nitrates. Design souce water concentration: 88 mg/L NO_3. Design finished water concentration: 45 mg/L NO_3. Does not include concentrate disposal or land cost.	0.72
4	Granular Activated Carbon	City of Riverside Public Utilities, GW sources, for TCE, DBCP (VOC, SOC) treatment.	0.48
5	Granular Activated Carbon	Carollo Engineers, anonymous utility, 2012 costs for treating SW source for TTHMs. Design souce water concentration: 0.135 mg/L. Design finished water concentration: 0.07 mg/L. Does not include concentrate disposal or land cost.	0.34
6	Granular Activated Carbon, Liquid Phase	LADWP, Liquid Phase GAC treatment at Tujunga Well field. Costs for treating 2 wells. Treament for 1,1 DCE (VOC). 2011-2012 costs.	1.47
7	Reverse Osmosis	Carollo Engineers, anonymous utility, 2012 costs for treating GW source for Nitrates. Design souce water concentration: 88 mg/L NO_3. Design finished water concentration: 45 mg/L NO_3. Does not include concentrate disposal or land cost.	0.78
8	Packed Tower Aeration	City of Monrovia, treatment to reduce TCE, PCE concentrations. 2011-12 costs.	0.42
9	Ozonation+ Chemical addition	SCVWD, STWTP treatment plant includes chemical addition + ozone generation costs to reduce THM/HAAs concentrations. 2009-2012 costs.	0.09

COST ESTIMATES FOR TREATMENT TECHNOLOGIES

(INCLUDES ANNUALIZED CAPITAL AND O&M COSTS)

No.	Treatment Technology	Source of Information	Estimated Unit Cost 2012 ACWA Survey Indexed to 2015* ($/1,000 gallons treated)
10	Ozonation+ Chemical addition	SCVWD, PWTP treatment plant includes chemical addition + ozone generation costs to reduce THM/HAAs concentrations, 2009-2012 costs.	0.19
11	Coagulation/Filtration	Soquel WD, treatment to reduce manganese concentrations in GW. 2011 costs.	0.73
12	Coagulation/Filtration Optimization	San Diego WA, costs to reduce THM/Bromate, Turbidity concentrations, raw SW a blend of State Water Project water and Colorado River water, treated at Twin Oaks Valley WTP.	0.83
13	Blending (Well)	Rancho California WD, GW blending well, 1150 gpm, to reduce fluoride concentrations.	0.69
14	Blending (Wells)	Rancho California WD, GW blending wells, to reduce arsenic concentrations, 2012 costs.	0.56
15	Blending	Rancho California WD, using MWD water to blend with GW to reduce arsenic concentrations. 2012 costs.	0.67
16	Corrosion Inhibition	Atascadero Mutual WC, corrosion inhibitor addition to control aggressive water. 2011 costs.	0.09

*Costs were adjusted from date of original estimates to present, where appropriate, using the Engineering News Record (ENR) annual average building costs of 2015 and 2012. The adjustment factor was derived from the ratio of 2015 Index/2012 Index.

Reference: Other Agencies

COST ESTIMATES FOR TREATMENT TECHNOLOGIES

(INCLUDES ANNUALIZED CAPITAL AND O&M COSTS)

No.	Treatment Technology	Source of Information	Estimated Unit Cost 2012 Other References Indexed to 2015* ($/1,000 gallons treated)
1	Reduction - Coagulation-Filtration	Reference: February 28, 2013, Final Report Chromium Removal Research, City of Glendale, CA. 100-2000 gpm. Reduce Hexavalent Chromium to 1 ppb.	1.58 - 9.95
2	IX - Weak Base Anion Resin	Reference: February 28, 2013, Final Report Chromium Removal Research, City of Glendale, CA. 100-2000 gpm. Reduce Hexavalent Chromium to 1 ppb.	1.62 - 6.78
3	IX	Golden State Water Co., IX w/disposable resin, 1 MGD, Perchlorate removal, built in 2010.	0.50
4	IX	Golden State Water Co., IX w/disposable resin, 1000 gpm, perchlorate removal (Proposed; O&M estimated).	1.08
5	IX	Golden State Water Co., IX with brine regeneration, 500 gpm for Selenium removal, built in 2007.	7.08
6	GFO/Adsorption	Golden State Water Co., Granular Ferric Oxide Resin, Arsenic removal, 600 gpm, 2 facilities, built in 2006.	1.85 -1.98
7	RO	Reference: Inland Empire Utilities Agency : Chino Basin Desalter. RO cost to reduce 800 ppm TDS, 150 ppm Nitrate (as NO3); approx. 7 mgd.	2.43
8	IX	Reference: Inland Empire Utilities Agency : Chino Basin Desalter. IX cost to reduce 150 ppm Nitrate (as NO3); approx. 2.6 mgd.	1.35

9	Packed Tower Aeration	Reference: Inland Empire Utilities Agency : Chino Basin Desalter. PTA-VOC air stripping, typical treated flow of approx. 1.6 mgd.	0.41
10	IX	Reference: West Valley WD Report, for Water Recycling Funding Program, for 2.88 mgd treatment facility. IX to remove Perchlorate, Perchlorate levels 6-10 ppb. 2008 costs.	0.56 - 0.80
11	Coagulation Filtration	Reference: West Valley WD, includes capital, O&M costs for 2.88 mgd treatment facility- Layne Christensen packaged coagulation Arsenic removal system. 2009-2012 costs.	0.37
12	FBR	Reference: West Valley WD/Envirogen design data for the O&M + actual capitol costs, 2.88 mgd fluidized bed reactor (FBR) treatment system, Perchlorate and Nitrate removal, followed by multimedia filtration & chlorination, 2012. NOTE: The capitol cost for the treatment facility for the first 2,000 gpm is $23 million annualized over 20 years with ability to expand to 4,000 gpm with minimal costs in the future. $17 million funded through state and federal grants with the remainder funded by WVWD and the City of Rialto.	1.67 - 1.76

*Costs were adjusted from date of original estimates to present, where appropriate, using the Engineering News Record (ENR) annual average building costs of 2015 and 2012. The adjustment factor was derived from the ratio of 2015 Index/2012 Index.

Table 3
Reference: Updated 2012 ACWA Cost of Treatment Table

COST ESTIMATES FOR TREATMENT TECHNOLOGIES
(INCLUDES ANNUALIZED CAPITAL AND O&M COSTS)

No.	Treatment Technology	Source of Information	Estimated 2012 Unit Cost Indexed to 2015* ($/1,000 gallons treated)
1	Granular Activated Carbon	Reference: Malcolm Pirnie estimate for California Urban Water Agencies, large surface water treatment plants treating water from the State Water Project to meet Stage 2 D/DBP and bromate regulation, 1998	0.57-1.08
2	Granular Activated Carbon	Reference: Carollo Engineers, estimate for VOC treatment (PCE), 95% removal of PCE, Oct. 1994,1900 gpm design capacity	0.26
3	Granular Activated Carbon	Reference: Carollo Engineers, est. for a large No. Calif. surf. water treatment plant (90 mgd capacity) treating water from the State Water Project, to reduce THM precursors, ENR construction cost index = 6262 (San Francisco area) - 1992	1.25
4	Granular Activated Carbon	Reference: CH2M Hill study on San Gabriel Basin, for 135 mgd central treatment facility for VOC and SOC removal by GAC, 1990	0.49-0.71
5	Granular Activated Carbon	Reference: Southern California Water Co. - actual data for "rented" GAC to remove VOCs (1,1-DCE), 1.5 mgd capacity facility, 1998	2.24
6	Granular Activated Carbon	Reference: Southern California Water Co. - actual data for permanent GAC to remove VOCs (TCE), 2.16 mgd plant capacity, 1998	1.46
7	Reverse Osmosis	Reference: Malcolm Pirnie estimate for California Urban Water Agencies, large surface water treatment plants treating water from the State Water Project to meet Stage 2 D/DBP and bromate regulation, 1998	1.68-3.22
8	Reverse Osmosis	Reference: Boyle Engineering, RO cost to reduce 1000 ppm TDS in brackish groundwater in So. Calif., 1.0 mgd plant operated at 40% of design flow, high brine line cost, May 1991	3.98
9	Reverse Osmosis	Reference: Boyle Engineering, RO cost to reduce 1000 ppm TDS in brackish groundwater in So. Calif., 1.0 mgd plant operated at 100% of design flow, high brine line cost, May 1991	2.45
10	Reverse Osmosis	Reference: Boyle Engineering, RO cost to reduce 1000 ppm TDS in brackish groundwater in So. Calif., 10.0 mgd plant operated at 40% of design flow, high brine line cost, May 1991	2.65
11	Reverse Osmosis	Reference: Boyle Engineering, RO cost to reduce 1000 ppm TDS in brackish groundwater in So. Calif., 10.0 mgd plant operated at 100% of design flow, high brine line cost, May 1991	2.05
12	Reverse Osmosis	Reference: Arsenic Removal Study, City of Scottsdale, AZ - CH2M Hill, for a 1.0 mgd plant operated at 40% of design capacity, Oct. 1991	6.65

COST ESTIMATES FOR TREATMENT TECHNOLOGIES

(INCLUDES ANNUALIZED CAPITAL AND O&M COSTS)

No.	Treatment Technology	Source of Information	Estimated 2012 Unit Cost Indexed to 2015* ($/1,000 gallons treated)
13	Reverse Osmosis	Reference: Arsenic Removal Study, City of Scottsdale, AZ - CH2M Hill, for a 1.0 mgd plant operated at 100% of design capacity, Oct. 1991	3.92
14	Reverse Osmosis	Reference: Arsenic Removal Study, City of Scottsdale, AZ - CH2M Hill, for a 10.0 mgd plant operated at 40% of design capacity, Oct. 1991	2.94
15	Reverse Osmosis	Reference: Arsenic Removal Study, City of Scottsdale, AZ - CH2M Hill, for a 10.0 mgd plant operated at 100% of design capacity, Oct. 1991	1.82
16	Reverse Osmosis	Reference: CH2M Hill study on San Gabriel Basin, for 135 mgd central treatment facility with RO to remove nitrate, 1990	1.83-3.22
17	Packed Tower Aeration	Reference: Analysis of Costs for Radon Removal... (AWWARF publication), Kennedy/Jenks, for a 1.4 mgd facility operating at 40% of design capacity, Oct. 1991	1.06
18	Packed Tower Aeration	Reference: Analysis of Costs for Radon Removal... (AWWARF publication), Kennedy/Jenks, for a 14.0 mgd facility operating at 40% of design capacity, Oct. 1991	0.56
19	Packed Tower Aeration	Reference: Carollo Engineers, estimate for VOC treatment (PCE) by packed tower aeration, without off-gas treatment, O&M costs based on operation during 329 days/year at 10% downtime, 16 hr/day air stripping operation, 1900 gpm design capacity, Oct. 1994	0.28
20	Packed Tower Aeration	Reference: Carollo Engineers, for PCE treatment by Ecolo-Flo Enviro-Tower air stripping, without off-gas treatment, O&M costs based on operation during 329 days/year at 10% downtime, 16 hr/day air stripping operation, 1900 gpm design capacity, Oct. 1994	0.29
21	Packed Tower Aeration	Reference: CH2M Hill study on San Gabriel Basin, for 135 mgd central treatment facility - packed tower aeration for VOC and radon removal, 1990	0.45-0.74
22	Advanced Oxidation Processes	Reference: Carollo Engineers, estimate for VOC treatment (PCE) by UV Light, Ozone, Hydrogen Peroxide, O&M costs based on operation during 329 days/year at 10% downtime, 24 hr/day AOP operation, 1900 gpm capacity, Oct. 1994	0.55
23	Ozonation	Reference: Malcolm Pirnie estimate for CUWA, large surface water treatment plants using ozone to treat water from the State Water Project to meet Stage 2 D/DBP and bromate regulation, *Cryptosporidium* inactivation requirements,1998	0.13-0.26
24	Ion Exchange	Reference: CH2M Hill study on San Gabriel Basin, for 135 mgd central treatment facility - ion exchange to remove nitrate, 1990	0.61-0.80

*Costs were adjusted from date of original estimates to present, where appropriate, using the Engineering News Record (ENR) annual average building costs of 2015 and 2012. The adjustment factor was derived from the ratio of 2015 Index/2012 Index.

Attachment 3

Health Risk Information for Public Health Goal Exceedance Reports

Prepared by

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

February 2016

Under the Calderon-Sher Safe Drinking Water Act of 1996 (the Act), water utilities are required to prepare a report every three years for contaminants that exceed public health goals (PHGs) (Health and Safety Code Section 116470 (b)(2)). The numerical health risk for a contaminant is to be presented with the category of health risk, along with a plainly worded description of these terms. The cancer health risk is to be calculated at the PHG and at the California maximum contaminant level (MCL). This report is prepared by the Office of Environmental Health Hazard Assessment (OEHHA) to assist the water utilities in meeting their requirements.

PHGs are concentrations of contaminants in drinking water that pose no significant health risk if consumed for a lifetime. PHGs are developed and published by OEHHA (Health and Safety Code Section 116365) using current risk assessment principles, practices and methods.

Numerical health risks. Table 1 presents health risk categories and cancer risk values for chemical contaminants in drinking water that have PHGs.

The Act requires that OEHHA publish PHGs based on health risk assessments using the most current scientific methods. As defined in statute, PHGs for non-carcinogenic chemicals in drinking water are set at a concentration "at which no known or anticipated adverse health effects will occur, with an adequate margin of safety." For carcinogens, PHGs are set at a concentration that "does not pose any significant risk to health." PHGs provide one basis for revising MCLs, along with cost and technological feasibility. OEHHA has been publishing PHGs since 1997 and the entire list published to date is shown in Table 1.

Table 2 presents health risk information for contaminants that do not have PHGs but have state or federal regulatory standards. The Act requires that, for chemical contaminants with California MCLs that do not yet have PHGs, water utilities use the federal maximum contaminant level goal (MCLG) for the purpose of complying with the requirement of public notification. MCLGs, like PHGs, are strictly health based and include a margin of safety. One difference, however, is that the MCLGs for carcinogens are set at zero because the US Environmental Protection Agency (US EPA) assumes there is no absolutely safe level of exposure to such chemicals. PHGs, on the other hand, are set at a level considered to pose no *significant* risk of cancer; this is usually a no more than one-in-one-million excess cancer risk (1×10^{-6}) level for a lifetime of exposure. In Table 2, the cancer risks shown are based on the US EPA's evaluations.

For more information on health risks: The adverse health effects for each chemical with a PHG are summarized in a PHG technical support document. These documents are available on the OEHHA Web site (http://www.oehha.ca.gov). Also, technical fact sheets on most of the chemicals having federal MCLs can be found at http://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants.

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Alachlor	carcinogenicity (causes cancer)	0.004	NA[5]	0.002	NA
Aluminum	neurotoxicity and immunotoxicity (harms the nervous and immune systems)	0.6	NA	1	NA
Antimony	digestive system toxicity (causes vomiting)	0.02	NA	0.006	NA
Arsenic	carcinogenicity (causes cancer)	0.000004 (4×10^{-6})	1×10^{-6} (one per million)	0.01	2.5×10^{-3} (2.5 per thousand)
Asbestos	carcinogenicity (causes cancer)	7 MFL[6] (fibers >10 microns in length)	1×10^{-6}	7 MFL (fibers >10 microns in length)	1×10^{-6} (one per million)
Atrazine	carcinogenicity (causes cancer)	0.00015	1×10^{-6}	0.001	7×10^{-6} (seven per million)

[1] Based on the OEHHA PHG technical support document unless otherwise specified. The categories are the hazard traits defined by OEHHA for California's Toxics Information Clearinghouse (online at: http://oehha.ca.gov/multimedia/green/pdf/GC_Regtext011912.pdf).
[2] mg/L = milligrams per liter of water or parts per million (ppm)
[3] Cancer Risk = Upper estimate of excess cancer risk from lifetime exposure. Actual cancer risk may be lower or zero. 1×10^{-6} means one excess cancer case per million people exposed.
[4] MCL = maximum contaminant level.
[5] NA = not applicable. Risk cannot be calculated. The PHG is set at a level that is believed to be without any significant public health risk to individuals exposed to the chemical over a lifetime.
[6] MFL = million fibers per liter of water.

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Barium	cardiovascular toxicity (causes high blood pressure)	2	NA	1	NA
Bentazon	hepatotoxicity and digestive system toxicity (harms the liver, intestine, and causes body weight effects[7])	0.2	NA	0.018	NA
Benzene	carcinogenicity (causes leukemia)	0.00015	1×10^{-6}	0.001	7×10^{-6} (seven per million)
Benzo[a]pyrene	carcinogenicity (causes cancer)	0.000007 (7×10^{-6})	1×10^{-6}	0.0002	3×10^{-5} (three per hundred thousand)
Beryllium	digestive system toxicity (harms the stomach or intestine)	0.001	NA	0.004	NA
Bromate	carcinogenicity (causes cancer)	0.0001	1×10^{-6}	0.01	1×10^{-4} (one per ten thousand)
Cadmium	nephrotoxicity (harms the kidney)	0.00004	NA	0.005	NA
Carbofuran	reproductive toxicity (harms the testis)	0.0017	NA	0.018	NA

[7] Body weight effects are an indicator of general toxicity in animal studies.

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Carbon tetrachloride	carcinogenicity (causes cancer)	0.0001	1×10^{-6}	0.0005	5×10^{-6} (five per million)
Chlordane	carcinogenicity (causes cancer)	0.00003	1×10^{-6}	0.0001	3×10^{-6} (three per million)
Chlorite	hematotoxicity (causes anemia) neurotoxicity (causes neurobehavioral effects)	0.05	NA	1	NA
Chromium, hexavalent	carcinogenicity (causes cancer)	0.00002	1×10^{-6}	0.01	5×10^{-4} (five per ten thousand)
Copper	digestive system toxicity (causes nausea, vomiting, diarrhea)	0.3	NA	1.3 (AL[8])	NA
Cyanide	neurotoxicity (damages nerves) endocrine toxicity (affects the thyroid)	0.15	NA	0.15	NA
Dalapon	nephrotoxicity (harms the kidney)	0.79	NA	0.2	NA

[8] AL = action level. The action levels for copper and lead refer to a concentration measured at the tap. Much of the copper and lead in drinking water is derived from household plumbing (The Lead and Copper Rule, Title 22, California Code of Regulations [CCR] section 64672.3).

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
1,2-Dibromo-3-chloropropane (DBCP)	carcinogenicity (causes cancer)	0.0000017 (1.7×10^{-6})	1×10^{-6}	0.0002	1×10^{-4} (one per ten thousand)
1,2-Dichloro-benzene (o-DCB)	hepatotoxicity (harms the liver)	0.6	NA	0.6	NA
1,4-Dichloro-benzene (p-DCB)	carcinogenicity (causes cancer)	0.006	1×10^{-6}	0.005	8×10^{-7} (eight per ten million)
1,1-Dichloro-ethane (1,1-DCA)	carcinogenicity (causes cancer)	0.003	1×10^{-6}	0.005	2×10^{-6} (two per million)
1,2-Dichloro-ethane (1,2-DCA)	carcinogenicity (causes cancer)	0.0004	1×10^{-6}	0.0005	1×10^{-6} (one per million)
1,1-Dichloro-ethylene (1,1-DCE)	hepatotoxicity (harms the liver)	0.01	NA	0.006	NA
1,2-Dichloro-ethylene, cis	nephrotoxicity (harms the kidney)	0.1	NA	0.006	NA
1,2-Dichloro-ethylene, trans	hepatotoxicity (harms the liver)	0.06	NA	0.01	NA
Dichloromethane (methylene chloride)	carcinogenicity (causes cancer)	0.004	1×10^{-6}	0.005	1×10^{-6} (one per million)
2,4-Dichloro-phenoxyacetic acid (2,4-D)	hepatotoxicity and nephrotoxicity (harms the liver and kidney)	0.02	NA	0.07	NA

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
1,2-Dichloro-propane (propylene dichloride)	carcinogenicity (causes cancer)	0.0005	1×10^{-6}	0.005	1×10^{-5} (one per hundred thousand)
1,3-Dichloro-propene (Telone II®)	carcinogenicity (causes cancer)	0.0002	1×10^{-6}	0.0005	2×10^{-6} (two per million)
Di(2-ethylhexyl) adipate (DEHA)	developmental toxicity (disrupts development)	0.2	NA	0.4	NA
Diethylhexyl-phthalate (DEHP)	carcinogenicity (causes cancer)	0.012	1×10^{-6}	0.004	3×10^{-7} (three per ten million)
Dinoseb	reproductive toxicity (harms the uterus and testis)	0.014	NA	0.007	NA
Dioxin (2,3,7,8-TCDD)	carcinogenicity (causes cancer)	5×10^{-11}	1×10^{-6}	3×10^{-8}	6×10^{-4} (six per ten thousand)
Diquat	ocular toxicity (harms the eye) developmental toxicity (causes malformation)	0.015	NA	0.02	NA
Endothall	digestive system toxicity (harms the stomach or intestine)	0.094	NA	0.1	NA
Endrin	hepatotoxicity (harms the liver) neurotoxicity (causes convulsions)	0.0018	NA	0.002	NA

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Ethylbenzene (phenylethane)	hepatotoxicity (harms the liver)	0.3	NA	0.3	NA
Ethylene dibromide	carcinogenicity (causes cancer)	0.00001	1×10^{-6}	0.00005	5×10^{-6} (five per million)
Fluoride	musculoskeletal toxicity (causes tooth mottling)	1	NA	2	NA
Glyphosate	nephrotoxicity (harms the kidney)	0.9	NA	0.7	NA
Heptachlor	carcinogenicity (causes cancer)	0.000008 (8×10^{-6})	1×10^{-6}	0.00001	1×10^{-6} (one per million)
Heptachlor epoxide	carcinogenicity (causes cancer)	0.000006 (6×10^{-6})	1×10^{-6}	0.00001	2×10^{-6} (two per million)
Hexachloroben-zene	carcinogenicity (causes cancer)	0.00003	1×10^{-6}	0.001	3×10^{-5} (three per hundred thousand)
Hexachloro-cyclopentadiene (HCCPD)	digestive system toxicity (causes stomach lesions)	0.002	NA	0.05	NA
Lead	developmental neurotoxicity (causes neurobehavioral effects in children) cardiovascular toxicity (causes high blood pressure) carcinogenicity (causes cancer)	0.0002	$<1\times10^{-6}$ (PHG is not based on this effect)	0.015 (AL[8])	2×10^{-6} (two per million)

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Lindane (γ-BHC)	carcinogenicity (causes cancer)	0.000032	1×10^{-6}	0.0002	6×10^{-6} (six per million)
Mercury (inorganic)	nephrotoxicity (harms the kidney)	0.0012	NA	0.002	NA
Methoxychlor	endocrine toxicity (causes hormone effects)	0.00009	NA	0.03	NA
Methyl tertiary-butyl ether (MTBE)	carcinogenicity (causes cancer)	0.013	1×10^{-6}	0.013	1×10^{-6} (one per million)
Molinate	carcinogenicity (causes cancer)	0.001	1×10^{-6}	0.02	2×10^{-5} (two per hundred thousand)
Monochloro-benzene (chlorobenzene)	nephrotoxicity (harms the kidney)	0.07	NA	0.07	NA
Nickel	developmental toxicity (causes increased neonatal deaths)	0.012	NA	0.1	NA
Nitrate	hematotoxicity (causes methemoglobinemia)	45 as nitrate	NA	10 as nitrogen (=45 as nitrate)	NA
Nitrite	hematotoxicity (causes methemoglobinemia)	1 as nitrogen	NA	1 as nitrogen	NA

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Nitrate and Nitrite	hematotoxicity (causes methemoglobinemia)	10 as nitrogen	NA	10 as nitrogen	NA
N-nitroso-dimethyl-amine (NDMA)	carcinogenicity (causes cancer)	0.000003 (3×10^{-6})	1×10^{-6}	none	NA
Oxamyl	general toxicity (causes body weight effects)	0.026	NA	0.05	NA
Pentachloro-phenol (PCP)	carcinogenicity (causes cancer)	0.0003	1×10^{-6}	0.001	3×10^{-6} (three per million)
Perchlorate	endocrine toxicity (affects the thyroid) developmental toxicity (causes neurodevelop-mental deficits)	0.001	NA	0.006	NA
Picloram	hepatotoxicity (harms the liver)	0.5	NA	0.5	NA
Polychlorinated biphenyls (PCBs)	carcinogenicity (causes cancer)	0.00009	1×10^{-6}	0.0005	6×10^{-6} (six per million)
Radium-226	carcinogenicity (causes cancer)	0.05 pCi/L	1×10^{-6}	5 pCi/L (combined $Ra^{226+228}$)	1×10^{-4} (one per ten thousand)
Radium-228	carcinogenicity (causes cancer)	0.019 pCi/L	1×10^{-6}	5 pCi/L (combined $Ra^{226+228}$)	3×10^{-4} (three per ten thousand)

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Selenium	integumentary toxicity (causes hair loss and nail damage)	0.03	NA	0.05	NA
Silvex (2,4,5-TP)	hepatotoxicity (harms the liver)	0.003	NA	0.05	NA
Simazine	general toxicity (causes body weight effects)	0.004	NA	0.004	NA
Strontium-90	carcinogenicity (causes cancer)	0.35 pCi/L	1×10^{-6}	8 pCi/L	2×10^{-5} (two per hundred thousand)
Styrene (vinylbenzene)	carcinogenicity (causes cancer)	0.0005	1×10^{-6}	0.1	2×10^{-4} (two per ten thousand)
1,1,2,2-Tetrachloro-ethane	carcinogenicity (causes cancer)	0.0001	1×10^{-6}	0.001	1×10^{-5} (one per hundred thousand)
Tetrachloro-ethylene (perchloro-ethylene, or PCE)	carcinogenicity (causes cancer)	0.00006	1×10^{-6}	0.005	8×10^{-5} (eight per hundred thousand)
Thallium	integumentary toxicity (causes hair loss)	0.0001	NA	0.002	NA
Thiobencarb	general toxicity (causes body weight effects) hematotoxicity (affects red blood cells)	0.07	NA	0.07	NA

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
Toluene (methylbenzene)	hepatotoxicity (harms the liver) endocrine toxicity (harms the thymus)	0.15	NA	0.15	NA
Toxaphene	carcinogenicity (causes cancer)	0.00003	1×10^{-6}	0.003	1×10^{-4} (one per ten thousand)
1,2,4-Trichloro-benzene	endocrine toxicity (harms adrenal glands)	0.005	NA	0.005	NA
1,1,1-Trichloro-ethane	neurotoxicity (harms the nervous system), reproductive toxicity (causes fewer offspring) hepatotoxicity (harms the liver) hematotoxicity (causes blood effects)	1	NA	0.2	NA
1,1,2-Trichloro-ethane	carcinogenicity (causes cancer)	0.0003	$1x10^{-6}$	0.005	2×10^{-5} (two per hundred thousand)
Trichloro-ethylene (TCE)	carcinogenicity (causes cancer)	0.0017	1×10^{-6}	0.005	3×10^{-6} (three per million)
Trichlorofluoro-methane (Freon 11)	accelerated mortality (increase in early death)	1.3	NA	0.15	NA

Table 1: Health Risk Categories and Cancer Risk Values for Chemicals with California Public Health Goals (PHGs)

Chemical	Health Risk Category[1]	California PHG (mg/L)[2]	Cancer Risk[3] at the PHG	California MCL[4] (mg/L)	Cancer Risk at the California MCL
1,2,3-Trichloro-propane (1,2,3-TCP)	carcinogenicity (causes cancer)	0.0000007 (7×10^{-7})	$1\text{x}10^{-6}$	none	NA
1,1,2-Trichloro-1,2,2-trifluoro-ethane (Freon 113)	hepatotoxicity (harms the liver)	4	NA	1.2	NA
Tritium	carcinogenicity (causes cancer)	400 pCi/L	$1\text{x}10^{-6}$	20,000 pCi/L	$5\text{x}10^{-5}$ (five per hundred thousand)
Uranium	carcinogenicity (causes cancer)	0.43 pCi/L	1×10^{-6}	20 pCi/L	5×10^{-5} (five per hundred thousand)
Vinyl chloride	carcinogenicity (causes cancer)	0.00005	1×10^{-6}	0.0005	1×10^{-5} (one per hundred thousand)
Xylene	neurotoxicity (affects the senses, mood, and motor control)	1.8 (single isomer or sum of isomers)	NA	1.75 (single isomer or sum of isomers)	NA

Table 2: Health Risk Categories and Cancer Risk Values for Chemicals without California Public Health Goals

Chemical	Health Risk Category[1]	U.S. EPA MCLG[2] (mg/L)	Cancer Risk[3] @ MCLG	California MCL[4] (mg/L)	Cancer Risk @ California MCL
Disinfection byproducts (DBPS)					
Chloramines	acute toxicity (causes irritation) digestive system toxicity (harms the stomach) hematotoxicity (causes anemia)	4[5,6]	NA[7]	none	NA
Chlorine	acute toxicity (causes irritation) digestive system toxicity (harms the stomach)	4[5,6]	NA	none	NA
Chlorine dioxide	hematotoxicity (causes anemia) neurotoxicity (harms the nervous system)	0.8[5,6]	NA	none	NA
Disinfection byproducts: haloacetic acids (HAA5)					
Chloroacetic acid	general toxicity (causes body and organ weight changes[8])	0.07	NA	none	NA

[1] Health risk category based on the U.S. EPA MCLG document or California MCL document unless otherwise specified.
[2] MCLG = maximum contaminant level goal established by U.S. EPA.
[3] Cancer Risk = Upper estimate of excess cancer risk from lifetime exposure. Actual cancer risk may be lower or zero. 1×10^{-6} means one excess cancer case per million people exposed.
[4] California MCL = maximum contaminant level established by California.
[5] Maximum Residual Disinfectant Level Goal, or MRDLG.
[6] The federal Maximum Residual Disinfectant Level (MRDL), or highest level of disinfectant allowed in drinking water, is the same value for this chemical.
[7] NA = not available.
[8] Body weight effects are an indicator of general toxicity in animal studies.

Table 2: Health Risk Categories and Cancer Risk Values for Chemicals without California Public Health Goals

Chemical	Health Risk Category[1]	U.S. EPA MCLG[2] (mg/L)	Cancer Risk[3] @ MCLG	California MCL[4] (mg/L)	Cancer Risk @ California MCL
Dichloroacetic acid	carcinogenicity (causes cancer)	0	0	none	NA
Trichloroacetic acid	hepatotoxicity (harms the liver)	0.02	0	none	NA
Bromoacetic acid	NA	none	NA	none	NA
Dibromoacetic acid	NA	none	NA	none	NA
Total haloacetic acids	carcinogenicity (causes cancer)	none	NA	0.06	NA
Disinfection byproducts: trihalomethanes (THMs)					
Bromodichloro-methane (BDCM)	carcinogenicity (causes cancer)	0	0	none	NA
Bromoform	carcinogenicity (causes cancer)	0	0	none	NA
Chloroform	hepatotoxicity and nephrotoxicity (harms the liver and kidney)	0.07	NA	none	NA
Dibromo-chloromethane (DBCM)	hepatotoxicity, nephrotoxicity, and neurotoxicity (harms the liver, kidney, and nervous system)	0.06	NA	none	NA
Total trihalomethanes (sum of BDCM, bromoform, chloroform and DBCM)	carcinogenicity (causes cancer), hepatotoxicity, nephrotoxicity, and neurotoxicity (harms the liver, kidney, and nervous system)	none	NA	0.08	NA

Table 2: Health Risk Categories and Cancer Risk Values for Chemicals without California Public Health Goals

Chemical	Health Risk Category[1]	U.S. EPA MCLG[2] (mg/L)	Cancer Risk[3] @ MCLG	California MCL[4] (mg/L)	Cancer Risk @ California MCL
Radionuclides					
Gross alpha particles[9]	carcinogenicity (causes cancer)	0 (^{210}Po included)	0	15 pCi/L[10] (includes ^{226}Ra but not radon and uranium)	up to $1x10^{-3}$ (for ^{210}Po, the most potent alpha emitter
Beta particles and photon emitters[9]	carcinogenicity (causes cancer)	0 (^{210}Pb included)	0	50 pCi/L (judged equiv. to 4 mrem/yr)	up to $2x10^{-3}$ (for ^{210}Pb, the most potent beta-emitter)

[9] MCLs for gross alpha and beta particles are screening standards for a group of radionuclides. Corresponding PHGs were not developed for gross alpha and beta particles. See the OEHHA memoranda discussing the cancer risks at these MCLs at http://oehha.studio-weeren.com/media/downloads/water/chemicals/phg/grossalphahealth.pdf.

[10] pCi/L = picocuries per liter of water.